

# Accepted Manuscript

Finite element analysis of ion transport in solid state nuclear waste form materials

F. Rabbi, K. Brinkman, J. Amoroso, K. Reifsnider

PII: S0022-3115(16)30762-0

DOI: [10.1016/j.jnucmat.2017.05.039](https://doi.org/10.1016/j.jnucmat.2017.05.039)

Reference: NUMA 50320

To appear in: *Journal of Nuclear Materials*

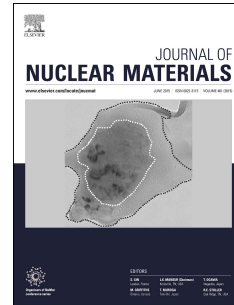
Received Date: 13 September 2016

Revised Date: 25 May 2017

Accepted Date: 26 May 2017

Please cite this article as: F. Rabbi, K. Brinkman, J. Amoroso, K. Reifsnider, Finite element analysis of ion transport in solid state nuclear waste form materials, *Journal of Nuclear Materials* (2017), doi: 10.1016/j.jnucmat.2017.05.039.

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.



## Finite Element analysis of ion transport in Solid State Nuclear Waste Form Materials

F. Rabbi<sup>1</sup>, K. Brinkman<sup>2</sup>, J. Amoroso<sup>3</sup>, and K. Reifsnider<sup>4</sup>

<sup>1</sup>University of South Carolina, <sup>2</sup>Clemson University, <sup>3</sup>Savannah River National Laboratory,

<sup>4</sup>University of Texas Arlington

Keywords: Diffusion, COMSOL, Nernst-Planck, Waste form

### Abstract

Release of nuclear species from spent fuel ceramic waste form storage depends on the individual constituent properties as well as their internal morphology, heterogeneity and boundary conditions. Predicting the release rate is essential for designing a ceramic waste form, which is capable of effectively storing the spent fuel without contaminating the surrounding environment for a longer period of time. To predict the release rate, in the present work a conformal finite element model is developed based on the Nernst Planck Equation. The equation describes charged species transport through different media by convection, diffusion, or migration. And the transport can be driven by chemical / electrical potentials or velocity fields. The model calculates species flux in the waste form with different diffusion coefficient for each species in each constituent phase. In the work reported, a 2D approach is taken to investigate the contributions of different basic parameters in a waste form design, i.e., volume fraction, phase dispersion, phase surface area variation, phase diffusion co-efficient, boundary concentration etc. The analytical approach with preliminary results is discussed. The method is postulated to be a foundation for conformal analysis based design of heterogeneous waste form materials.

### 1. Introduction

Radioactive waste streams resulting from legacy weapons production as well as advanced commercial fuel cycles<sup>i</sup>, present researchers with the challenge to manage the waste in an efficient and safe manner. An efficient system must have the capability to contain a radioactive material within itself and limit the release of the waste material in the surrounding environment to an allowable release rate. Among different waste form materials, SYNROC-C is a titanate based ceramic composed of four different targeted phases – zirconolite, hollandite, perovskite, and pyrochlore<sup>ii</sup>. Different Separation processes isolate several important radionuclides that need

Download English Version:

<https://daneshyari.com/en/article/5453968>

Download Persian Version:

<https://daneshyari.com/article/5453968>

[Daneshyari.com](https://daneshyari.com)